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Analysis of The Impact of Traffic And Pedestrianization Environment in Malioboro

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ABSTRACT The phenomenon of the increasing number of Malioboro tourists every year raises traffic problems in the area. Starting from congestion, increasing vehicle exhaust emissions, to increasing side friction. This has put pressure on the Yogyakarta city government to plan to improve traffic management by transforming the Malioboro area into a pedestrianized area. Pedestrianization in urban centers has widely practiced in big cities in various countries. This application has an impact on significant changes in traffic flow on roads around the Malioboro area. This study simulated a traffic flow scenario on roads around Malioboro using VISSIM software to determine the saturation level of the flow and the resulting emissions. Generation and attraction data could be done by household interview surveys or traffic surveys on the roads to be modeled. In this work, the generation and attraction data have been obtained from the traffic survey results. VISSIM is Microscopic flow simulation software for traffic models. In this simulation, the existing condition where Malioboro road is still open for motorized vehicles is compared with the Malioboro scenario, which is being closed from motorized vehicle, with several gyratory alternatives on the surrounding. To find out the emission data released due to transportation activities, a node is placed at several simulated intersections. Three alternatives have been compared. It is recommended to use the third alternative, which has less traffic impacts than the others.

KEYWORDS Pedestrianization; Malioboro, Vissim; Simulation.

1 INTRODUCTION

Pedestrianization in urban centers has widely practiced in big cities in various countries, generally in countries in Europe and America. Pedestrianization in big cities in Asia are still hard to find, especially in developing countries. Bangkok is one of the big cities in Southeast Asia that has successfully implemented pedestrianization. The Khao San shopping center area in Bangkok is the location for implementing pedestrianization (Kumar and Ross, 2006). In addition, to reduce noise and accidents, pedestrianization also had an economic impact which increased its sales quantity (Shahideh. 2013). A previous study stated that more than 100 cities around the world have implemented pedestrianization, would increase the city's income by 49% and remain stable at 25%. Meanwhile, cities in Austria, Germany, and Scandinavia experienced an enhancement in turnover of more than 60% (OECD, 1978). Pedestrianization also encourages local people to buy utilities in their own environment and attracts more customers from a wider area, as well as improving community relations (Manzano et. al. 2014 and Cakiroglu, 2012).

Application of pedestrian facilities will have an impact on increasing traffic volume and emission on the surrounding roads and resulting in a further increase in traffic density at the intersection. An increase in traffic volume at intersection with light stop caused an increase in fuels consumption which resulted in further increase in emissions (Gunawan and Budi, 2017). The increase in emission is not only due to an increase in number of vehicles but also vehicles that stop or run at low speed will reduce engine speed. Research on vehicles operated using both Liquid gas and Pertamax fuels indicate that at lower engine speed produce higher emissions (Esaputra et al., 2016).

Malioboro is a shopping center area in Yogyakarta City, Indonesia, which is crowded with domestic and foreign daily visitors (Cahya et. al., 2017).

Increasing the number of visitors also means increasing the requirements for accommodation and transportation. Currently, the crowd of the Malioboro area has been increased with motorized vehicles, both private and public vehicles, which caused congestion and increase air pollution (Sugiyanto et. al., 2010). This prompted the government to turn the Malioboro area into a pedestrian area (Pradipto et. al., 2014). Rezika (2016) conducted a study on the effectiveness of the arrangement of the pedestrian area in Malioboro where will prioritize pedestrians, non-motorized vehicles, and public transportation by modeling three additional parking pocket points, namely Abu Bakar Ali, Yogyakarta Tourism Office, and the former Indra Cinema building. Lestarini et. al 2019 also conducted an evaluation study on the implementation of pedestrianization in the Malioboro area. The modeling results of the closing at Malioboro Street from motorized vehicles have impacted on the increasing volume of vehicles by 4% to 20% on weekdays, and 8% to 31% on holidays. Unfortunately, this study did not state an alternative solution. Therefore, this study aims to carry out comprehensive traffic management, by making changes in the environment so that congestion can be minimized.

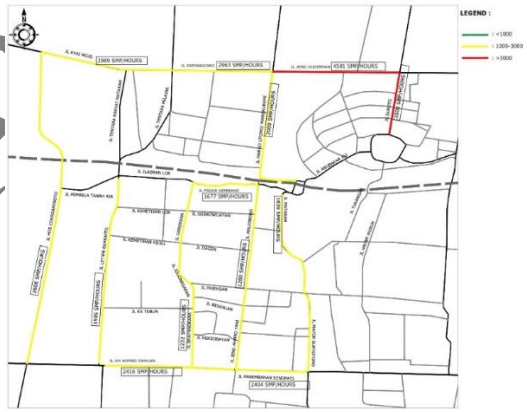
VISSIM software has been used for this modeling.. VISSIM is Microscopic flow simulation software for traffic models (Abou-Senna t. al. 2013). Each characteristic of vehicles and pedestrians can be simulated individually (Chen et. al. 2019) The unique operational conditions contained in a transportation system can be simulated by VISSIM. Data can be added to be analyzed according to the user's plan. Various effectiveness calculations can be added in the VISSIM software, such as delay, queue speed, travel time and stops.

2 METHODOLOGY AND ANALYSIS

VISSIM is a computer program for modeling traffic conditions. Several types of data were required, including road network data and inter-zone attraction generation data. The necessary data could be obtained from primary and secondary surveys. Generation and attraction data could be done by household interview surveys or traffic surveys on the roads to be modeled. In this work, the generation and attraction data have been obtained from the traffic survey results.

2.1 Traffic Surveys

The traffic count survey aims to find the volume of traffic flow (Q) on the road that will be modeling. The results of the traffic calculation of the enumeration survey based on the 1997 MKJI (Manuala Kapasitas Jalan Indonesia = Indonesian Highway Capacity Manual), issued by Directorate General of Highways show the volume of traffic flow (Q) during the peak hours in the morning on weekdays. The traffic volume survey at morning peak hours is shown in Figure 1.



Jl. = jalan = street

Figure 1 Traffic survey result image.

2.2 VISSIM 10.00 Program

According to PTV-AG (2015), VISSIM is a microscopic flow simulation software for urban traffic models. It is developed by PTV (Planung Transportasi Verkehr AG) in Karlsruhe, Germany. The name comes from "Verkehr Stadten - SIMulationsmodell" (German for "Traffic in the city - simulation model"). VISSIM was started in 1992 and is currently the global market leader. The VISSIM simulation model was selected to calibrate the road conditions.

VISSIM is a microscopic simulation or microsimulation, which means that each vehicle

and pedestrian characteristic will be simulated individually. VISSIM can simulate the unique operational conditions contained in a transportation system. Users can add data to be analyzed according to the user's plan. Various effectiveness calculations can be entered in the VISSIM software, in general, including delay, queue speed, travel time and stop. VISSIM has been used to analyze networks of all sizes of individual junction distances to entire metropolitan areas.

According to PTV-AG (2015), VISSIM provides animation capabilities with enhancements in 3-D simulation of vehicle types (motorbikes, passenger cars, trucks, and trains). Also, video clips can be recorded in the program, with the ability to dynamically change views and perspectives. Other visual elements, such as trees, buildings, transit facilities, and traffic signs, can be incorporated into the 3-D animation.

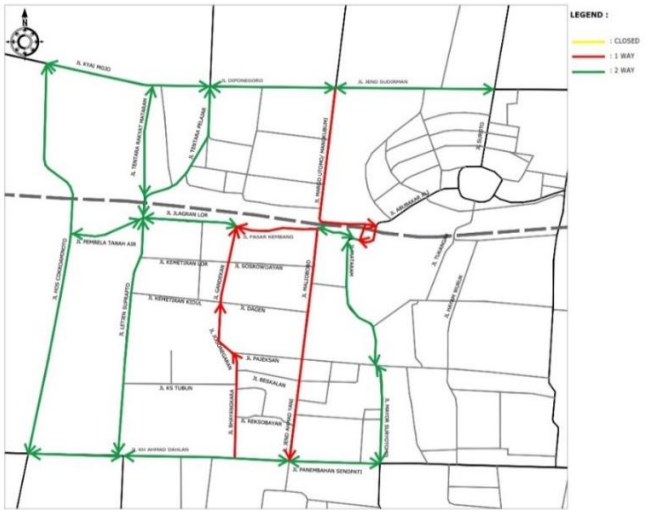
2.3 VISSIM Result

In this simulation, the existing condition where Malioboro road is still open for motorized vehicles is compared with the Malioboro scenario, which is being closed from motorized vehicles, with several gyratory alternatives on the surrounding. Simulated scenarios are shown in Table 1.

Table 1 Traffic flow direction change in gyratory scenario.

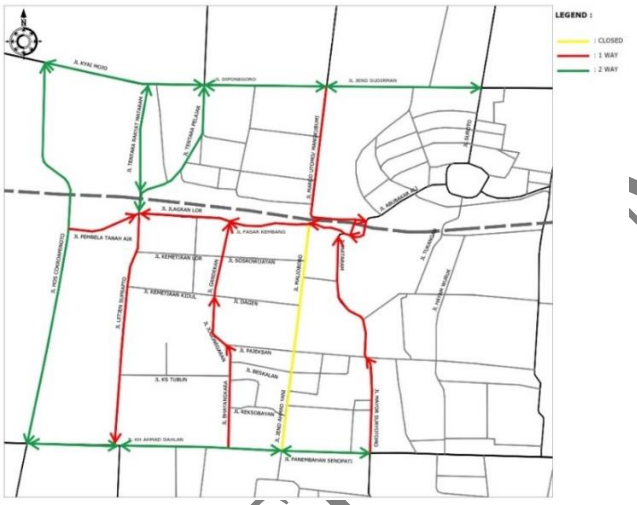
Road Name	Existing	1st Gyratory	2nd Gyratory	3rd Gyratory
HOS Cokroaminoto	Two Way	Two Way	Two Way	Two Way
Kyai Mojo	Two Way	Two Way	Two Way	Two Way
Jendral Sudirman	Two Way	Two Way	Two Way	Two Way
Pangeran Mangkubumi	One Way to South	One Way to South	One Way to South	One Way to South
Tentara Rakyat Mataram	Two Way	Two Way	Two Way	Two Way
Tentara Pelajar	Two Way	Two Way	Two Way	Two Way
Pembela Tanah Air	Two Way	One Way to East	One Way to East	One Way to East
Jlagran Lor	Two Way	One Way to West	One Way to West	One Way to West
Pasar Kembang	One Way to West	One Way to West	One Way to West	One Way to West
Letjend Suprapto	Two Way	One Way to South	One Way to South	One Way to South
Gandekan	One Way to North	One Way to North	One Way to North	One Way to North
Jogonegaran	One Way to North	One Way to North	One Way to North	One Way to North
Bhayangkara	One Way to North	One Way to North	One Way to North	One Way to North
Malioboro	One Way to South	Close	Close	Close
Mataram	Two Way	One Way to North	One Way to North	One Way to North
Suryotomo	Two Way	One Way to North	One Way to North	One Way to North
Senopati	Two Way	Two Way	Two Way	Two Way
KH A Dahlan (0 Km - Ngabean intersection)	Two Way	Two Way	One Way to East	Two Way
KH A Dahlan (Ngabean intersection – Wirobrajan intersection)	Two Way	Two Way	Two Way	Two Way
Abu Bakar Ali South Parking	Two Way	One Way to West	One Way to West	One Way to West
Abu Bakar Ali East Parking	One Way to North	One Way to North	One Way to North	Two Way

The existing conditions by Vissim simulation (after validation and calibration) and alternatives gyratory are shown in Figures 2, 3,4 and 5.



Jl. = jalan = street

Figure 2 Traffic flow on the existing condition of a road section.

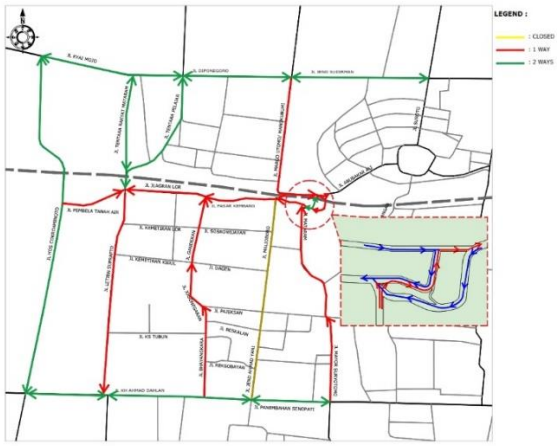


Jl. = jalan = street

Figure 3 Traffic flow in 1st alternative gyratory scenario.

Jl = jalan = street

Figure 4 Traffic flow in 2nd alternative gyratory scenario.



Jl. = jalan = street

Figure 5 Traffic flow in 3rd alternative gyratory scenario

For the 3rd alternative, there is a special rule for traffic flow (see Figure 5) which shown in additional picture, allowing two way system (red and blue colors) to the North of Mataram street, controlled by traffic signal.

After running Vissim in each scenario, the simulation results are obtained. The simulation results are in the form of traffic volume on roads and emissions generated by vehicles at several intersections. The following are the results of the traffic simulation as shown at Table 2 and Figure 6. Traffic flows have been simulated by Vissim to find the equilibrium of the traffic flow.

Table 2 Traffic simulation result and the difference of the 3 gyratory scenario simulation.

No	Road Name	Existing Simulation Result	1st Gyratory Scenario Simulation Result*) and (%difference**))	2nd Gyratory Scenario Simulation Result*) and (%difference**))	3rd Gyratory Scenario Simulation Result*) and (%difference**))
1	Kyai Mojo	1890	1879 (-1)	2037 (8)	2120 (12)
2	P. Diponegoro	2668	3024 (13)	3177 (19)	3116 (17)
3	Sudirman	2981	2951 (-1)	3113 (4)	3344 (12)
4	Suroto	4678	5038 (8)	4849 (4)	4768 (2)
5	Mangkubumi	1237	850 (-31)	909 (-27)	1455 (18)
6	Malioboro	1342	0 (-100)	0 (-100)	0 (-100)
7	Mataram	1236	1128 (-9)	1534 (24)	1015 (-18)
8	P. Senopati	1712	**2880 (68)**	2276 (33)	2727 (59)
9	Centre of KHA Dahlan (Ngabean - PKU)	1918	2483 (29)	2039 (6)	2227 (16)
10	West of KHA Dahlan (Wirobrajan - Ngabean)	2438	2365 (-3)	2352 (-4)	2110 (-13)
11	HOS Cokroaminoto	1930	1951 (1)	2140 (11)	2023 (5)
12	Letjend. Suprapto	1149	1057 (-8)	1593 (39)	1149 (0)
13	Bhayangkara	1006	272 (-73)	140 (-86)	535 (-47)
14	ABA under the rail	1044	871 (-17)	1611 (54)	767 (-27)
15	Pasar Kembang	1017	1517 (49)	**2665 (162)**	1675 (65)
16	Kleringan	1209	832 (-31)	889 (-26)	1416 (17)
17	ABA Chruch	1252	1723 (38)	2346 (87)	1778 (42)
18	ABA Parking	896	444 (-50)	415 (-54)	357 (-60)
19	East of KHA Dahlan (PKU - 0 KM)	2109	2681 (27)	1886 (-11)	2411 (14)
20	Tukangan	1831	1505 (-18)	1166 (-36)	1258 (-31)
21	Hayam Wuruk	1649	2680 (63)	3122 (89)	**3193 (94)**

*) Traffic volume.

**) %Difference (increase or decrease) of Traffic volume of Gyratory scenario and existing traffic volume : positive value mean increase, while negative value means decrease.

From the table data above, in the 1st gyratory scenario the traffic volume on roads that have decreased by more than 30% are Mangkubumi, Bhayangkara, Kleringan, in front of Portable Parking Structure of Abu Bakar Ali roads. Meanwhile, those that experienced an increase of more than 30% were the Panembahan Senopati road, Pasar Kembang, Abu Bakar Ali in front of the Kotabaru Church and Hayam Wuruk, while the highest increase of traffic volume is about 68% which was detected at P. Senopati road.

In the 2nd gyratory scenario, which is different from gyratory 1, is that the Jalan KHA Dahlan

section is in the direction from the Ngabean intersection to the KM Zero intersection. From the table data above, the roads that have decreased more than 30% are the Bhayangkara, in front of Portable Parking Structure of Abu Bakar Ali roads, and Tukangan roads. Meanwhile, those that experienced an increase of more than 30% were the Panembahan Senopati, Letjend. Suprapto, Abu Bakar Ali roads under the tracks, Pasar Kembang, Abu Bakar Ali in front of the Kotabaru Church, and Hayam Wuruk, while the highest increase of traffic volume is about 162% which was detected at Pasar Kembang road.

In the 3rd gyratory scenario which is different from 1st gyratory, is the flow from Kleringan road head to Malioboro, turn right, walk on the right side of the road and there is an APILL before the PLN landmark, flow from Mataram road to Kleringan by the right-side lane, APILL from Kleringan road one-phase with APILL on Abu Bakar Ali's arm. From the table data above, the roads that have decreased more than 30% are the Bhayangkara, in front of Portable Parking Structure of Abu Bakar Ali roads, and Tukangan roads. Meanwhile, those that experienced an increase of more than 30% were the Panembahan Senopati road, Pasar Kembang, Abu Bakar Ali in front of the Kotabaru Church, and Hayam Wuruk, while the highest increase of traffic volume is about 94% which was detected at Hayam Wuruk road. Traffic modeling result is shown in Figure 6.

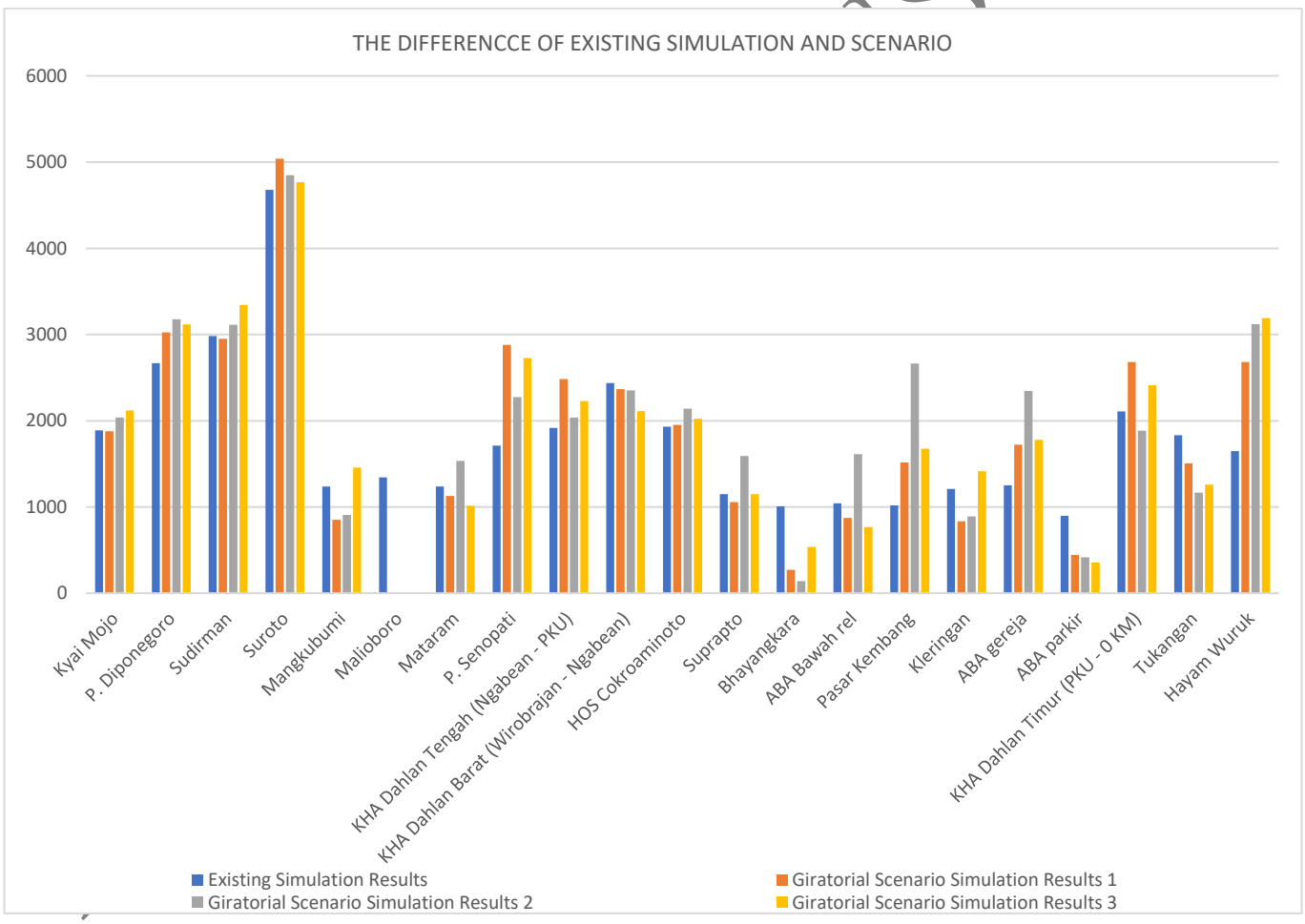
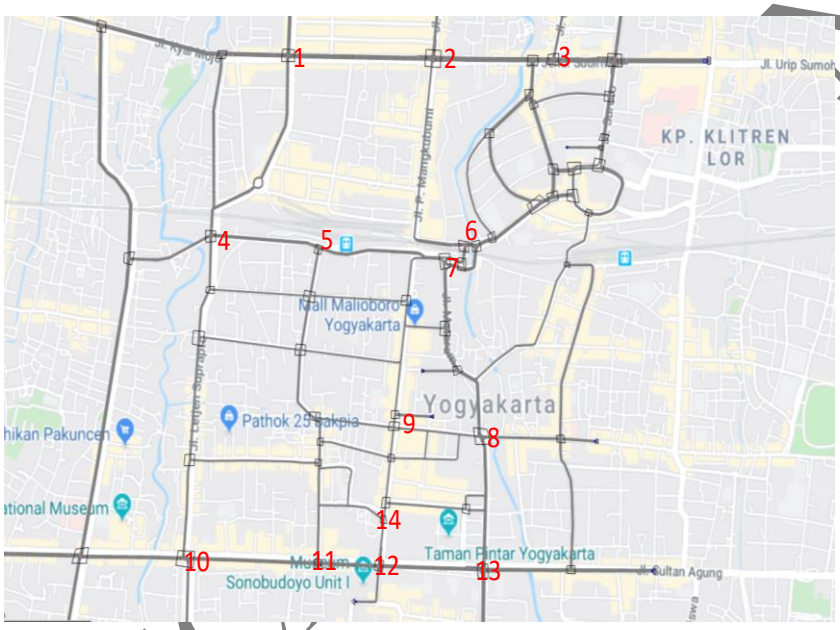


Figure 6 Traffic modeling result diagram.

From the diagram above, it can be explained that the road sections in several scenarios after the closing scenario of the Malioboro road which consistently increases the volume of vehicles are Jalan P. Diponegoro, Suroto, Senopati, KHA Dahlan (Sp Ngabean - PKU), HOS Cokroaminoto, Pasar Kembang, Abu Bakar Ali in front of Kotabaru and Hayam Wuruk Church, while the ones that descend are the KHA Dahlan (Sp Wirobrajan - Sp Ngabean), Bhayangkara, Abu Bakar Ali roads in front of the parking lot and Tukangan. Other roads in several scenarios, the traffic volume goes down and up, namely, the Kyai Mojo road in scenario 1 going down and scenario 2, 3 going up, Sudirman in scenario 1 going down and scenario 2, 3 going up, Mangkubumi scenario 1,2 going down, scenario 3 up, Mataram scenario 1, 3 goes down and scenario 2 goes up, Letjend. Suprapto scenario 1.3 goes down, scenario 2 goes up, Abu Bakar Ali is under scenario 1.3 down, scenario 2 goes up, Klerangan scenario 1.2 goes down, scenario 3 goes up, KHA Dahlan (Sp PKU - Sp Zero Km) scenario 2 decreases, scenario 1.3 increases.

2.3.1 Emission Simulation Result

To find out the emission data released due to transportation activities, a node is placed at several simulated intersections. The following are location of the intersections (light stop) that are attached to the node to find out the emission data (see Figure 7). Emission can also be counted by Vissim. The emission diagram is shown in Figure 8.



Legend:

1. Pingit
2. Tugu
3. Sudirman. Mc Donald
4. Jlagran
5. Gandekan
6. Kleringan
7. Anim ABA
8. Melia
9. Pajeksan
10. Ngabean
11. PKU
12. 0 KM
13. Gondomanan
14. Ngejaman

Figure 7 Node / intersection data output of fuel and pollution consumption.

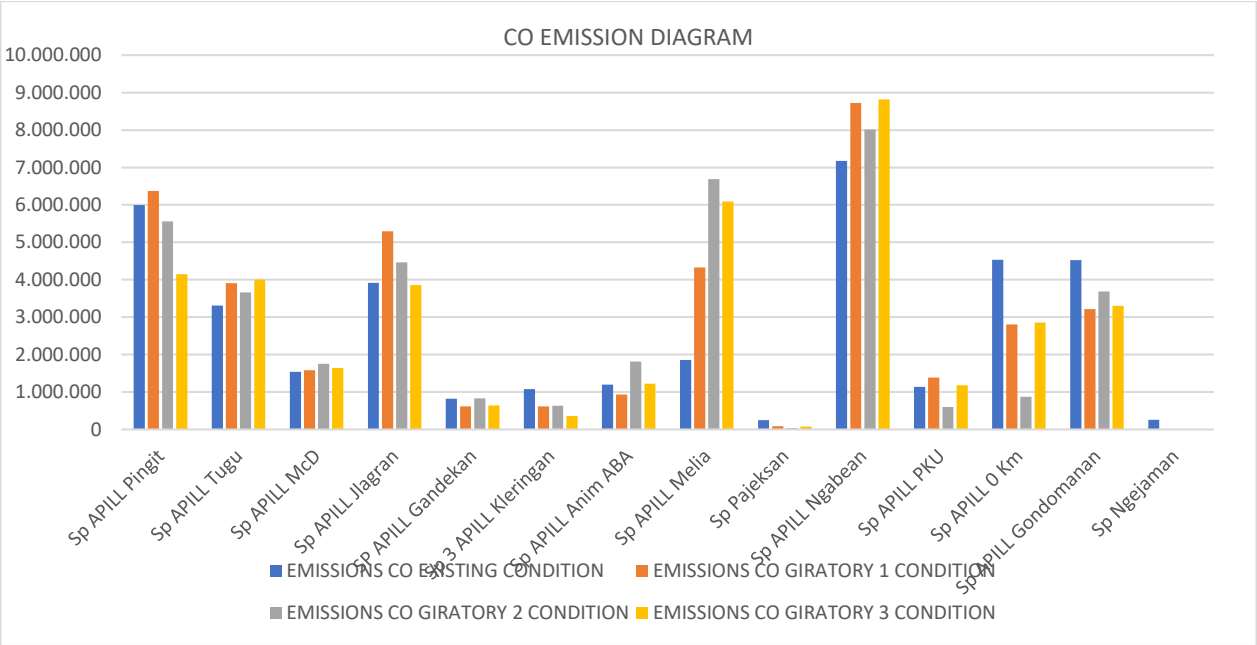


Figure 8 CO emission diagram.

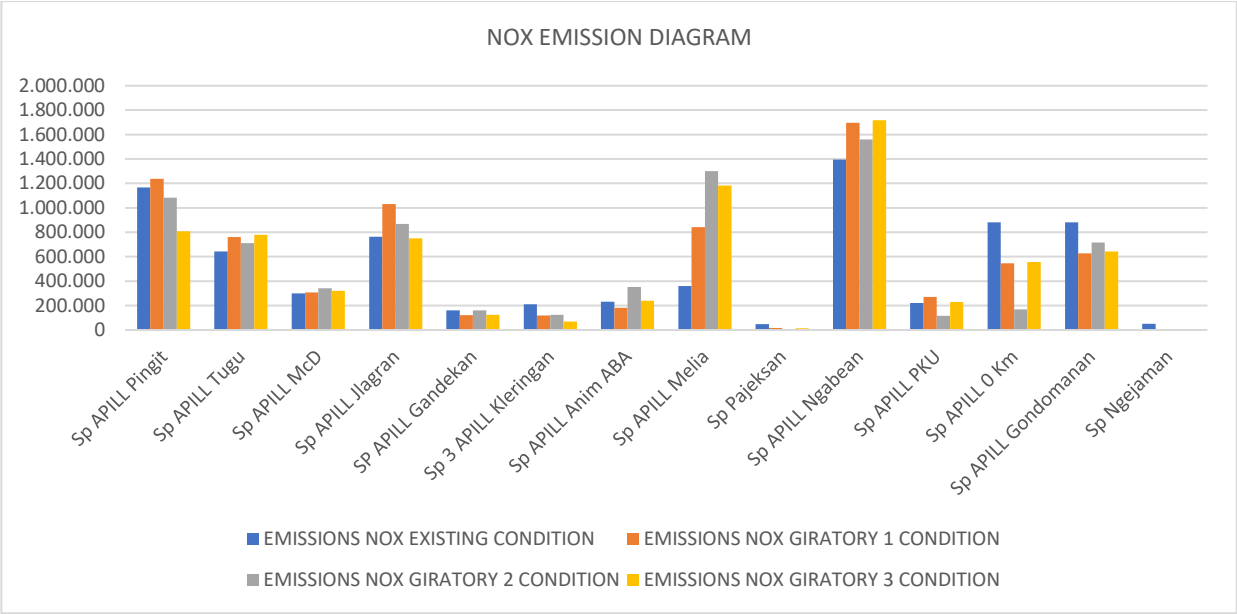
Traffic closing of Malioboro road by 3 Gyratory scenarios were caused a change (decrease or increase) of the CO emission condition at intersections and light stops around it.

As shown at Figure 8, the intersection with CO emissions was consistently increase in all scenarios is at the Melia intersection light stop, Ngabean intersection light stop, and Tugu intersection light stop. The highest increasing of the CO emission for the 3 Gyratory scenarios was detected at Melia intersection light stop. The CO emition condition at the intersection increases about 133% for the 1st Gyratory, 261% for 2nd Gyratory and 228% for the 3rd Gyratori. This condition may be caused by the increasing of traffic flow come from Senopati road which they will continue to the Abu Bakar Ali or to Hayam Wuruk road. This reason can be confirmed from at Table 2 which the increasing of traffic flow at Senopati and Hayam Wuruk were very high in all Gyratory scenarios.

The CO emission condition at the Ngabean intersection increases about 18% for the 1st Gyratory scenario, 11% for 2nd Gyratory scenario and 21% for the 3rd Gyratory scenario. This condition may be caused by the increasing of traffic flow come from Centre of KHA Dahlan road and Letjend.Suprapto road which they will continue to the Wahid Hasyim road. This reason can be confirmed from at Table 2 which the increasing of traffic flow at Centre of KHA Dahlan road was high in all Gyratory scenarios and at Letjend. Suprapto road was high for the 2nd Gyratory scenario.

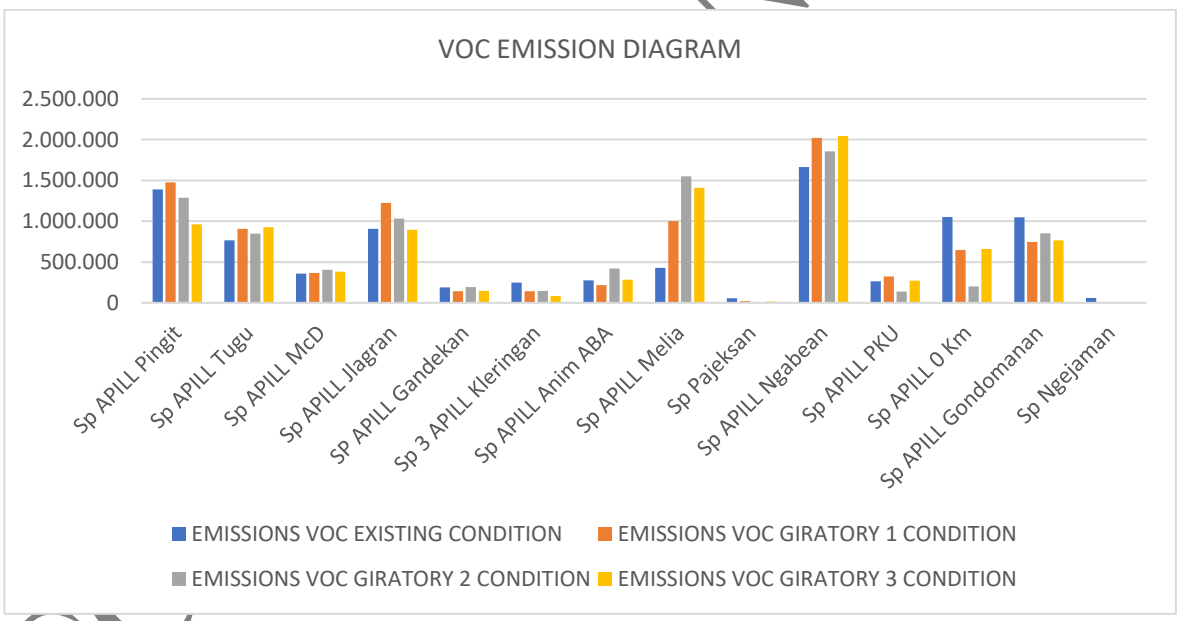
The CO emission condition at the Tugu intersection increases about 22% for the 1st Gyratory scenario, 12% for 2nd Gyratory scenario and 23% for the 3rd Gyratory scenario. This condition may be caused by the increasing of traffic flow come from P. Diponegoro road which they will continue to the Mangkubumi, Sudirman road. This reason can be confirmed from at Table 2 which the increasing of traffic flow at P. Diponegoro road was increase in all Gyratory scenarios.

Based on simulation of all scenarios for the emission of NOX and VOC which compare to the existing condition give the percentage difference of their value indicated similar with the CO emission value as shown in Figures 9, 10 and 11. The difference of emissions between the scenarios and existing condition as described before has positive correlation with the fuel consumption as can be seen at Figure 11 below.



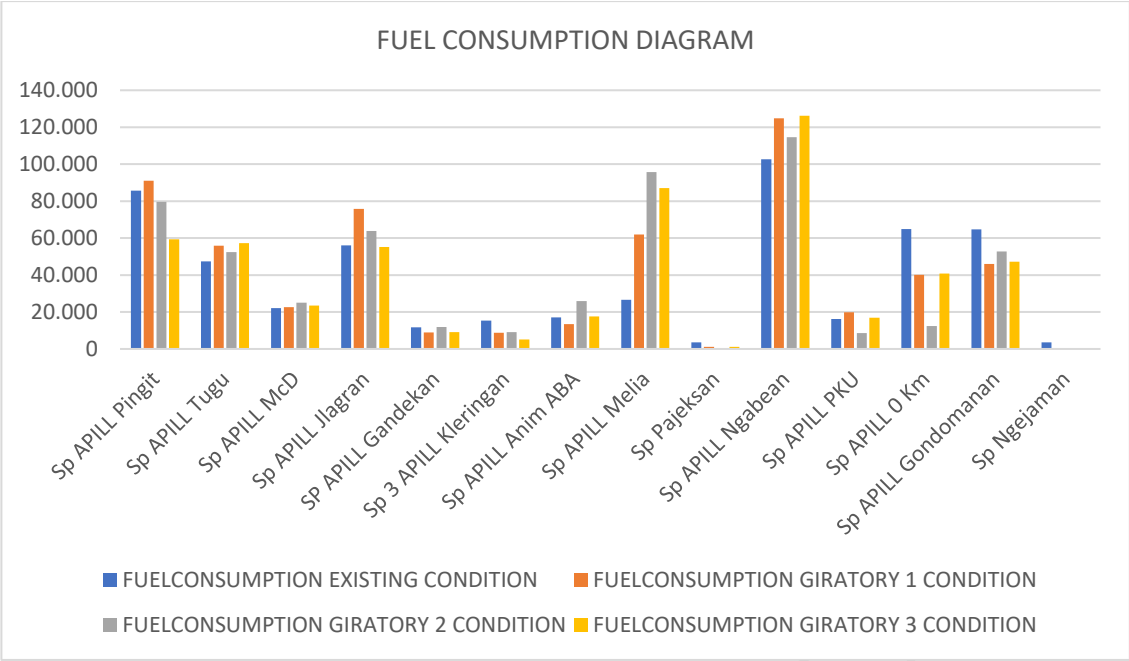
Sp APILL = simpang ber APILL = signalized intersectionl; Sp = simpang tak bersinyal = unsignalized intersection

Figure 9 NOX emission diagram.



Sp APILL = simpang ber APILL = signalized intersection; Sp = simpang tak bersinyal = unsignalized intersection

Figure 10 VOC emission diagram



Sp APILL = simpang ber APILL = signalized intersection; Sp = simpang tak bersinyal = unsignalized intersection.

Figure 11 Fuel consumption diagram.

From the data above, the intersections with the consistent increase in fuel consumption in all scenarios is at the Tugu intersection light stop, Melia intersection light stop, and Ngabean intersection light stop and consequently increases the emission of CO, NOX and VOC.

3 CONCLUSIONS

1. The first alternative, by making Mataram / Suryotomo roads and Letjen Suprapto roads one way, it will cause high traffic jams on KHA Dahlan road.
2. The second alternative is to make the KHA Dahlan road one-way, will reduce congestion on the KHA Dahlan road, but increase the flow through the Pasar Kembang road, and there is a concern that there will be many violations on the KHA Dahlan road.
3. The third alternative, by continuing to make the KHA Dahlan road two-way, but making the Abu Bakar Ali road to Kotabaru in two directions, will reduce congestion on the KHA Dahlan road, shifting some of the flow around Kotabaru.
4. The simulation results show that all alternatives show the highest emissions in the Ngabean intersection light stop cause by the highest traffic volume, while the highest increasing of emission is detected in the Melia intersection light stop.
5. It is recommended to implement a third alternative. It has the less negative traffic impact.

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